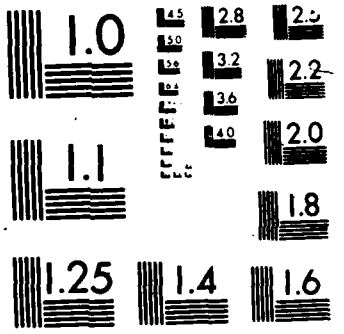
AD-A172 946 DORO TRANSPORTATION RATE TABLES - USER'S MANUAL(U) 1/1
DEFENSE LOGISTICS AGENCY ALEXANDRIA VA K P SMITH
JUN 86

UNCLASSIFIED F/G 14/1 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.8
3.2
3.6
4.0
4.5
5.0

DORO TRANSPORTATION RATE TABLES - USER'S MANUAL

Operations Research and Economic Analysis Office

JUNE 1986

DTIC FILE COPY

ELE
OCT 1 0 1986

This document has been approved for public release and sale; its distribution is unlimited.

DORO TRANSPORTATION RATE TABLES

USER'S MANUAL

JUNE 1986

Captain Kevin P. Smith
Operations Research and Economic Analysis Office
Headquarters, Defense Logistics Agency
Cameron Station, Alexandria, Virginia 22304-6100

DEFENSE LOGISTICS AGENCY
HEADQUARTERS
CAMERON STATION
ALEXANDRIA, VIRGINIA 22314

DLA-LO

FOREWORD

This report summarizes the analysis and creation of transportation cost tables for use in DLA Operations Research study efforts. The analysis was performed by the Operations Research and Economic Analysis Management Support Office for the Directorate of Supply Operations, Transportation Division.

Transportation cost data are essential inputs to many of the studies conducted in support of DLA. This analysis develops three alternative methods for estimating transportation costs and provides instructions on application of the methodologies.

ROGER C. ROY
Acting Assistant Director,
Policy and Plans

QUALITY INSPECTED 4

Approved for Public Release, Distribution Unlimited.
Per Ms. Cleo Ridgeway, DLA/LO

Distribution/
Availability Codes
Dist
A-1

Table of Contents

Title	Page
Foreword	iii
Table of Contents	v
I. Introduction	1
II. Application of Rate Tables	1
A. State Based First Destination Rates	1
B. DORO Cluster Based First Destination Rates	2
C. Mileage Based First Destination Rates	3
D. State Based Second Destination Rates	4
E. DORO Cluster Based Second Destination Rates	6
F. Mileage Based Second Destination Rates	6
III. Rate Development Methodology	7
IV. First Destination Rate Development	8
A. Introduction	8
B. State Based First Destination Rates	8
C. DORO Cluster Based First Destination Rates	9
D. Mileage Based First Destination Rates	9
V. Second Destination Rate Development	10
A. Introduction	10
B. State Based Second Destination Rates	10
C. DORO Cluster Based Second Destination Rates	11
D. Mileage Based Second Destination Rates	11
VI. Conclusions	11

I. INTRODUCTION

Transportation cost estimating methodologies have been developed for use in DORO study efforts. This report provides instructions for using these rates and details the methodology used in their development.

Three separate estimates are available for both first and second destination rates. The three methods of estimating transportation costs provide different levels of accuracy. For first destination rates, the three estimates listed in order of increasing accuracy are based on state pairs, DORO cluster pairs, or origin state/mileage data. For second destination rates, the three estimates (again listing in order of increasing accuracy) are based on depot/state pairs, depot/DORO cluster pairs, and depot/mileage data.

The actual application of the rates is left to the user. The rate structures lend themselves to FORTRAN or COBOL applications and could be modified for use in SPSS or SAS applications. These rates were tested against actual data using a FORTRAN program. Therefore, less work will be required for a FORTRAN based application because much of the code is already written.

The next section describes each rate structure and provides examples of how to apply the rate tables. First destination rates are covered first followed by the second destination rates.

II. APPLICATION OF RATE TABLES

A. State Based First Destination Rates

For first destination rates based on state pairs:

Data source: GOR.TAG.RT1S8602

Data description: Each record in this file contains rates for one state pair, the record format is as follows:

Variable	Column Positions	Data Format
Origin State	1-2	A2
Destination State	4-5	A2
Class 1 Rate*	7-15	F9.4
Class 2 Rate	16-24	F9.4
Class 3 Rate	25-33	F9.4
Class 4 Rate	34-42	F9.4
Class 5 Rate	43-51	F9.4
Class 6 Rate	52-60	F9.4
Class 7 Rate	61-69	F9.4
Class 8 Rate	70-78	F9.4
Class 9 Rate	79-87	F9.4
Class 10 Rate	88-96	F9.4
Class 11 Rate	97-105	F9.4

*Rate classes are determined from the shipment weight as follows:

Class	Weights	Class	Weights
1	100-199	7	10000-14999
2	200-499	8	15000-19999
3	500-999	9	20000-24999
4	1000-1999	10	25000-29999
5	2000-4999	11	30000-OVER
6	5000-9999		

Use of these rates is accomplished by first determining the appropriate record in the data file. This depends on the origin and destination state of the shipment for which cost data is needed. Once the appropriate record has been found, the next step is to determine which weight class rate applies by using the table above. The applicable rate per pound is multiplied by the shipment weight to come up with a cost estimate. Finally, the estimate is compared to the cost of a minimum weight shipment in the next higher weight class. The minimum of these two transportation cost estimates should be used.

The example which follows should clear up any questions concerning the application of these rates. For this example, assume we need an estimated transportation cost for a shipment weighing 4500 pounds, originating in Virginia, and having a destination in New York.

Step 1 - Find the appropriate record in the rate data file. The first sixty columns of this record are:

```
1.......10........20........30........40........50........60
 VA NY   0.3367   0.1299   0.0898   0.0777   0.0523   0.0465
```

Step 2 - Determine weight class, a 4500 pound shipment falls into weight class number 5. Therefore, the rate in columns 43-51 will be used to determine a transportation cost estimate.

Step 3 - Multiply the weight by the rate (4500 * 0.0523) to get a cost estimate of $235.35.

Step 4 - Determine the cost of a minimum weight shipment in the next higher weight class (5000 * 0.0465) to get $232.50.

Step 5 - Use the minimum of the two cost estimates ($232.50) as the estimated transportation cost for this shipment.

B. <u>DORO Cluster Based First Destination Rates</u>

For first destination rate based on DORO cluster pairs:

Data source: GOR.TAG.RT1C8602

Data description: Each record in this file contains rates for one DORO cluster pair, the record format is as follows:

Variable	Column Positions	Data Format
Origin Cluster	1-2	I2
Destination Cluster	4-5	I2
Class 1 Rate	7-15	F9.4
Class 2 Rate	16-24	F9.4
Class 3 Rate	25-33	F9.4
Class 4 Rate	34-42	F9.4
Class 5 Rate	43-51	F9.4
Class 6 Rate	52-60	F9.4
Class 7 Rate	61-69	F9.4
Class 8 Rate	70-78	F9.4
Class 9 Rate	79-87	F9.4
Class 10 Rate	88-96	F9.4
Class 11 Rate	97-105	F9.4

Use of these rates is accomplished in the same manner as the state based first destination rates. DORO cluster numbers are defined according to the first three digits of the location zip code as listed in 'GOR.TAG.ZIP.CLUSTER'.

C. Mileage Based First Destination Rates

For first destination rates based on origin state and shipment mileage:

Data source: GOR.TAG.RT1M8602

Data description: Each record in this file contains the y-intercept and slope of the appropriate rate equation based on mileage. A separate equation applies to each of nine origin state tariff regions and the eleven weight classes. The the record format is as follows:

Variable	Column Positions	Data Format
Origin Tariff Region	1-3	I3
Weight Class	4-6	I3
Y-Intercept	7-20	F14.6
Slope	21-34	E14.5

Use of the mileage based rates is different than either state or cluster based rate structures. To use these rates the user must first determine the appropriate origin tariff region. The origin tariff region for each state is listed alphabetically by state below.

State	Tariff Region	State	Tariff Region	State	Tariff Region	State	Tariff Region
1-AL	9	13-IL	3	25-MT	1	37-PA	4
2-AR	8	14-IN	3	26-NC	9	38-RI	5
3-AZ	7	15-KS	2	27-ND	2	39-SC	9
4-CA	6	16-KY	9	28-NE	2	40-SD	2
5-CO	7	17-LA	8	29-NH	5	41-TN	9
6-CT	5	18-MA	5	30-NJ	4	42-TX	8
7-DC	4	19-MD	4	31-NM	7	43-UT	7
8-DE	4	20-ME	5	32-NV	6	44-VA	4
9-FL	9	21-MI	3	33-NY	4	45-VT	5
10-GA	9	22-MN	2	34-OH	3	46-WA	1
11-IA	2	23-MO	2	35-OK	8	47-WI	3
12-ID	1	24-MS	9	36-OR	1	48-WV	4
						49-WY	7

Given the origin tariff region, the next step is to determine the weight class for the shipment. This is accomplished using the weight class table shown in the discussion for state based first destination rates. The origin tariff region and weight class point to the correct y-intercept and slope for the mileage based rate equation. Multiply the shipment miles by the slope and add the y-intercept value. The result is the charge per pound. Taking the weight in pounds times the charge per pound value will result in the rate estimate for the shipment.

As an example of how this rate structure would be applied, assume an estimated transportation cost is needed for a shipment weighing 565 pounds, originating in Virginia and traveling 1000 miles.

Step 1 - Determine the origin tariff region using the table shown above. the origin tariff region for Virginia (VA) is 4.

Step 2 - Determine the weight class for the shipment from the table above. the weight class is 3.

Step 3 - Find the record containing the y-intercept and slope values for origin tariff region 4 and weight class 3. The appropriate y-intercept is 0.120027 and the slope is 0.58402E-04.

Step 4 - Apply the rate equation. The charge per pound is 0.120027 + (1000 * 0.00058402). The estimated cost is: (0.704040 * 565) = $397.78

D. State Based Second Destination Rates

For second destination rates based on depot/state pairs:

Data source: GOR.TAG.RT2S8602

Data description: Each record in this file contains rates for one depot/state pair, the record format is as follows:

Variable	Column Positions	Data Format
Origin Depot	1-2	I2
Destination State	4-5	A2
Class 1 Rate	7-15	F9.4
Class 2 Rate	16-24	F9.4
Class 3 Rate	25-33	F9.4
Class 4 Rate	34-42	F9.4
Class 5 Rate	43-51	F9.4
Class 6 Rate	52-60	F9.4
Class 7 Rate	61-69	F9.4
Class 8 Rate	70-78	F9.4
Class 9 Rate	79-87	F9.4
Class 10 Rate	88-96	F9.4
Class 11 Rate	97-105	F9.4

Use of these rates is accomplished by first determining the appropriate record in the data file. This depends on the origin depot and destination state of the shipment for which cost data is needed. Once the appropriate record has been found, the next step is to determine which weight class rate applies by using the table above. The applicable rate per pound is multiplied by the shipment weight to come up with a cost estimate. Finally, the estimate is compared to the cost of a minimum weight shipment in the next higher weight class. The minimum of these two transportation cost estimates should be used.

The table below defines the DLA depot numbers (1 - 6) used in this rate file.

Depot Number	Depot Name	Depot ID
1	Richmond, VA	DDRV
2	Columbus, OH	DDCO
3	Mechanicsburg, PA	DDMP
4	Tracy, CA	DDTC
5	Ogden, UT	DDOU
6	Memphis, TN	DDMT

The example which follows should clear up any questions concerning the application of these rates. For this example, assume we need an estimated transportation cost for a shipment weighing 4500 pounds, originating at DDRV, and having a destination in New York.

Step 1 - Find the appropriate record in the rate data file. The first sixty columns of this record are:

```
1.......10........20........30........40........50........60
 1 NY    0.3537   0.1484   0.1111   0.0876   0.0775   0.0651
```

Step 2 - Determine weight class, a 4500 pound shipment falls into weight class number 5. Therefore, the rate in columns 43-51 will be used to determine a transportation cost estimate.

Step 3 - Multiply the weight by the rate (4500 * 0.0775) to get a cost estimate of $348.75.

Step 4 - Determine the cost of a minimum weight shipment in the next higher weight class (5000 * 0.0651) to get $325.50.

Step 5 - Use the minimum of the two cost estimates ($325.50) as the estimated transportation cost for this shipment.

E. DORO Cluster Based Second Destination Rates

For second destination rates based on depot/DORO cluster pairs:

Data source: GOR.TAG.RT2C8602

Data description: Each record in this file contains rates for one DORO cluster pair, the record format is as follows:

Variable	Column Positions	Data Format
Origin Depot	1-2	I2
Destination Cluster	4-5	I2
Class 1 Rate	7-15	F9.4
Class 2 Rate	16-24	F9.4
Class 3 Rate	25-33	F9.4
Class 4 Rate	34-42	F9.4
Class 5 Rate	43-51	F9.4
Class 6 Rate	52-60	F9.4
Class 7 Rate	61-69	F9.4
Class 8 Rate	70-78	F9.4
Class 9 Rate	79-87	F9.4
Class 10 Rate	88-96	F9.4
Class 11 Rate	97-105	F9.4

Use of these rates is accomplished in the same manner as the depot to state based second destination rates. DORO cluster numbers are defined according to the first three digits of the location zip code as listed in 'GOR.TAG.ZIP.CLUSTER'.

F. Mileage Based Second Destination Rates

For second destination rates based on origin depot and shipment mileage:

Data source: GOR.TAG.RT2M8602

Data description: Each record in this file contains the y-intercept and slope of the appropriate rate equation based on mileage. A separate equation applies to each of the six origin depots and the eleven weight classes. The record format is as follows:

Variable	Column Positions	Data Format
Origin Depot Number	1-3	I3
Weight Class	4-6	I3
Y-Intercept	7-20	F14.6
Slope	21-34	E14.5

Use of these mileage based rates is different than either state or cluster based structures. To use these rates the user must first determine the appropriate origin depot. Given the origin depot number, the next step is to determine the weight class of the shipment. This is accomplished using the weight class table shown in the discussion for state based first destination rates. The origin depot number and weight class point to the correct y-intercept and slope for the mileage based rate equation. Multiply the shipment miles by the slope and add the y-intercept value. The result is the charge per pound. Taking the weight in pounds times the charge per pound value will result in the rate estimate for the shipment.

As an example of how this rate structure would be applied, assume an estimated transportation cost is needed for a shipment weighing 565 pounds, originating at DDRV and traveling 1000 miles.

Step 1 - Determine the origin depot number (DDRV = 1).

Step 2 - Determine the weight class for the shipment from the table above, the weight class is 3.

Step 3 - Find the record containing the y-intercept and slope values for origin depot number 4 and weight class 3. The appropriate y-intercept is 0.075249 and the slope is 0.81329E-04.

Step 4 - Apply the rate equation. The charge per pound is 0.075249 + (1000 * 0.00081329) = $0.8885/lb. The estimated charge is: 0.8885 * 565 = $502.02.

III. RATE DEVELOPMENT METHODOLOGY

The development of freight rates involved first obtaining a data base of actual freight shipment charges. This data base was obtained from the FINS data files for FY84 and the first two quarters of FY85. The second step was select appropriate records based on the type of shipment (i.e., first or second destination). Several consistency checks were performed during this second step. These consistency checks eliminated records which contained obviously bad data (i.e., input errors) and records which contained inconsistent data.

The third step was to append additional information onto each record. For instance, in order to compute mileage, the data base was matched against the MOWASP address file and against CN4 data by Standard Point Location Code (SPLC) to obtain origin and destination latitude and longitude. The lat/long pairs were used to compute mileage using a simplistic straight

line computation. Another example of the information appended to each record is the DORO cluster numbers. These numbers are based on the first three digits of the zip code of each location.

Once the first and second destination data bases were developed, three different rate structures were obtained. The first rate structure is based on destination state, the second on destination cluster, and the third on shipment mileage. These rate structures are discussed below.

IV. FIRST DESTINATION RATE DEVELOPMENT

A. Introduction

The initial data base consists of several fields from the FINS data files. These data fields are: origin and destination state, SPLC code, Government Bill of Lading Code (GBLOC), shipment weight, and shipment charges. Only shipment modes 'AA', 'AG', 'AR', 'AV', 'AX', 'KW', and 'MF' are selected. These modes correspond to freight shipments. First destination shipment records are selected based on the last two digits of the origin GBLOC. A value of 'SK' implies a first destination shipment administered by DCAS. These shipments include both contractor to depot shipments and Direct Vendor Delivery (DVD) shipments to customers. Another case selection criteria is that both origin and destination must be within the CONUS. Finally, only shipments with total weight from 100 to 250,000 pounds are selected.

B. State Based First Destination Rates

The Statistical Package for the Social Sciences (SPSS) was employed to develop state based first destination rates. Cases are aggregated by origin and destination states and by weight class. Both the average charge per pound and the number of cases are saved for each state pairing. The next step is to insure the rates are both complete and consistent.

Rate consistency and completeness are checked using a FORTRAN program. This program fills in missing rates by averaging the rates from the four closest neighboring destination states. In cases where no rates are available from the four closest neighbors, the overall average rate is used. Once the matrix has been filled in, the next step is to insure the rates for all eleven weight classes are consistent for each origin/destination state pair. Consistency implies that larger shipment weights going between the same two points are charged less per pound of weight. This assumption is easily verified in the actual data. Insuring this level of consistency involves three steps. First, the weight class which carries the most credence is identified as the one for which the most raw data was available. The next step is to check for consistency on each lower weight class. The process involves identifying an acceptable range of values for the next lower weight class by using a plus or minus two standard deviation bound on acceptable values. If the next lower weight class rate falls within the bound, then it is used as the actual rate. If not, then the next lower weight class rate is determined exactly by applying the average percentage increase (developed from all data) to the current weight class rate. The final step is to check for consistency of

each weight class which is higher than the class identified in step 1. The same process is employed except that in cases where a new rate must be computed, the new rate is determined from the average percentage decrease from the current class to the next higher weight class.

The result of this process is a complete and consistent array of rates. The final step is to check the computed rates against the original data base to determine how accurately the rates will predict the actual shipment costs. A third FORTRAN program is employed to accomplish this test. Each record is read in and an estimated cost is computed. The actual and estimated costs are summed and reported at the end of the run. For the original data base (slightly over 63,000 FINS records), the state based rates resulted in total estimated charges which were 95 percent of the actual shipment charges.

C. DORO Cluster Based First Destination Rates

Development of the cluster based rates involved the same process as state based rates. The difference is in the size of the aggregated array output by SPSS. There are 78 CONUS clusters so the total number of cells in the cluster based rate array is 78*78*11 or 66,924 cells as compared to 49*49*11 or 26,411 cells for the state based rate array. This threefold increase in cells resulted in many more cells for which no observations were available since the same number of observations (about 63,000) go into both rate structures.

The final test of the cluster based rates resulted in total estimated charges of which were 98 percent of the actual charges over 63,031 shipment records. This increase in accuracy is probably due to the division of large states into several clusters which provides more consistent input to the rate array.

D. Mileage Based First Destination Rates

Mileage based rates are developed using linear regression techniques. Several different ways of applying regression to the rates were looked at before finally deciding on a breakdown by origin state tariff region and weight class. The alternatives involved some different variables (for instance, origin/destination states) and some variable transformations (for instance, logs and square roots). However, the breakdown by origin state tariff region and weight class was chosen because of the relatively small number of equations which had to be developed (9 tariff regions by 11 weight classes for a total of 99 seperate regressions) and because the regression equations employed for this breakdown were a simple function of the shipment mileage.

The resulting rate equation for each breakdown is $Y = AX + B$

where, Y = charge per pound
X = shipment mileage
A = the slope of the regression equation
and B = the Y-intercept value.

A large majority of the regression runs resulted in significant values for the slope and y-intercepts. The decision was made to use all regression results in the actual rate equations (whether or not the regression run was significant). This decision was made for two reasons. The first reason for using all results was consistency. All rates can be computed using the same basic equation. The second reason involves the reasons behind the regression runs which were not significant. For the majority of these runs, there were a small number of observations and/or extreme observations.

The test of actual to estimated costs for mileage based rates resulted in total estimated charges which were 101 percent of the actual charges.

V. SECOND DESTINATION RATE DEVELOPMENT

A. Introduction

The initial data base consists of several fields from the FINS data files. These data fields are: origin and destination SPLC and GBLOC, origin depot, and shipment weight and mileage. Only shipment modes 'AA', 'AG', 'AR', 'AV', 'AX', 'KW', and 'MF' are selected. These modes correspond to freight shipments. Second destination shipment records are identified by comparing origin GBLOCs to the six DLA depot GBLOCs. The other case selection criteria are the same as for first destination records.

B. State Based Second Destination Rates

The Statistical Package for the Social Sciences (SPSS) was employed to develop state based second destination rates. Cases are aggregated by origin depot, destination state, and weight class. Both the average charge per pound and the number of cases are saved for each depot/state/weight class combination. The next step is to insure the rates are both complete and consistent.

Rate consistency and completeness are checked using a FORTRAN program. This program fills in missing rates by averaging the rates from the four closest neighboring destination states. In cases where no rates are available from the four closest neighbors, the overall average rate is used. Once the matrix has been filled in, the next step is to insure the rates for all eleven weight classes are consistent. The consistency check is accomplished in the same way as for first destination state based rates.

The result of this process is a complete and consistent array of rates. The final step is to check the computed rates against the original data base to determine how accurately the rates will predict the actual shipment costs. A third FORTRAN program is employed to accomplish this test. Each record is read in and an estimated cost is computed. The actual and estimated costs are summed and reported at the end of the run. For the original data base of 318,924 records, the state based rates resulted in total estimated charges which were 99 percent of the actual shipment charges.

C. DORO Cluster Based Second Destination Rates

Again, development of the cluster based rates involved the same process as state based rates. The final test of the cluster based rates resulted in total estimated charges of which were 95 percent of the actual charges over 318,924 shipment records.

D. Mileage Based Second Destination Rates

Mileage based second destination rates were developed in exactly the same way as the first destination mileage based rates. The same form of the regression equation provided a reasonably good fit to the data. For second destination rates, the breakdown was by depot and weight class resulting in 6*11 equals 66 total regression equations.

The test of actual to estimated costs for mileage based rates resulted in total estimated charges which were 102 percent of the actual charges.

VI. CONCLUSIONS

As a result of this rate development project, several alternatives are available for calculating shipment charges in future DORO study efforts. These rate structures are there to be used; however, several things affect the application of the rates.

First, as in any project involving real world data, the FINS data on actual shipment charges were found to contain many errors. Some of these problems were solved by applying several data consistency checks as a first step in developing the data base. However, these data checks could not catch every data problem. Therefore, the rates reflect a small amount of inaccurate data.

The second factor affecting application of these rates involves the inconsistency of actual charges found in the FINS data. There is no way to accurately predict what a given charge will be because of the myriad of factors which go into determining the actual rate. As a result of these inconsistencies, the estimated charges obtained by employing any of these rate structures will not match well with actual charges when compared on an individual shipment basis. These rates are only applicable when applied over a large number of shipments.

The final factor affects application of the mileage based rate structures only. Shipment mileages were computed using a simplistic straight line algorithm based on latitudes and longitudes. Several other methods are available for determining shipment mileages. The latitude/longitude method was chosen because it provided more usable data, because it was relatively easy to apply, and because it ran quickly on the computer. Applying these rate structures using mileages obtained in some other manner could result in inconsistent cost estimates.

END

11-86

DTIC